Mega-Node Sr.

MODEL 3000

KAY ELECTRIC COMPANY

OPERATING AND MAINTENCE INSTRUCTIONS

ISSUE A

Mega-Node Sr.

MODEL 3000

KAY ELECTRIC COMPANY

MAPLE AVENUE • PINE BROOK, N. J. • CAPITAL 6-4000

© 1960 Kay Electric Co.

POLICY COVERING REPRODUCTION
AND USE OF TECHNICAL DATA

KAY ELECTRIC COMPANY

DATA CONTAINED IN THIS MANUAL IS COPYRIGHTED BY KAY ELECTRIC COMPANY AND IS FURNISHED SOLELY FOR THE PURPOSE OF PROVIDING INSTRUCTIONS FOR OPERATION AND MAINTENANCE OF THE APPARATUS DESCRIBED HEREIN. SAID DATA SHALL NOT BE USED BY THE PURCHASER OR THE GOVERNMENT FOR PROMOTIONAL PROCUREMENT, DEVELOPMENT, OR MANUFACTURING PURPOSES, NOR SHALL THE DATA BE REPRODUCED OR DISCLOSED WITHOUT PERMISSION FROM KAY ELECTRIC COMPANY. IN THE EVENT OF RESALE OF THE APPARATUS TO THE GOVERNMENT BY THE PURCHASER, THE PURCHASER SHALL NOTIFY THE GOVERNMENT OF THE LIMITED RIGHT TO USE SAID DATA.

TABLE OF CONTENTS

Paragraph *Page*

SECTION I, GENERAL DESCRIPTION

1-1 Introduction 1
1-2 General Description 1
1-3 Specifications 1

SECTION II, INSTALLATION

2-1 General Instructions 2
2-2 Installation 2
2-3 Interconnection Data 2
A. Method Using Power-Level Meter 4
B. Method Using An AC Voltmeter And Fixed Pad Connections 4
C. Method Using AC Voltmeter Connections (Relative Noise Measurement) 4
D. Y-Factor Method 4

SECTION III, OPERATION

3-1 Function of Panel Controls 5
3-2 Noise Figure Measurement Techniques 5
3-3 Accuracy of Noise Figure Measurements 8
3-4 Method Using The 'Excess Noise Temperature' (Y-Factor) 9

SECTION IV, THEORY OF OPERATION

4-1 Noise Measurement Theory 12
4-2 Noise Figure Measurements 12
4-3 Requirements of the Noise-Diode Generator 13
4-4 Analysis of Power Supply Circuit 14

SECTION V, MAINTENANCE

5-1 Introduction 15
5-2 Adjustment of Internal Controls 16
5-3 Replacement of Noise Diode (TT-1) 16
5-4 Parts List 18
5-5 Reshipment Instructions 21

LIST OF ILLUSTRATIONS

Figure No. *Page*

1-1	Mega-Node Sr. Model 3000 ..... facing	1
2-1	Equipment Interconnections Using Power Level Indicator	3
2-2	Equipment Interconnections Using AC Voltmeter (Unknown Law)	3
2-3	Equipment Interconnections for Relative Noise Measurements	3
3-1	Transit Time Correction Chart	7
5-1	Noise Diode Life Expectancy Chart	17
5-2	Mega-Node Sr. Model 3000 Schematic Diagram, KD-6433-C	19, 20

Figure I-1, MEGA-NODE SR. MODEL 3000

SECTION I
GENERAL DESCRIPTION

I-1 INTRODUCTION.

The MEGA-NODE MODEL 3000 is one of a family of calibrated random noise generators produced by Kay. The compound name MEGA-NODE indicates the frequency range of the instrument (MEGAcycle region) and NOise dioDE, indicating the noise source.

The instrument incorporates a coaxial-type, tungsten-filament noise diode employed as a temperature-limited noise generator. The operating range is from 1 to 3000 mc and generator impedance is held substantially constant across this frequency range. The error introduced by impedance variation (a troublesome deficiency in many noise generators) is minimized. With the MEGA-NODE 3000 rapid, accurate measurement of receiver gain or noise figure can be accomplished without tedious calculation of effective bandwidth, or the use of calibration charts and slide rule.

While it is not the intent of this manual to furnish a comprehensive discourse on the subject of noise-figure measurements, several methods of accurately determining noise figure are covered.

I-2 GENERAL DESCRIPTION.

The MEGA-NODE MODEL 3000 is designed for either bench-top use, or when removed from its cabinet, for mounting in a standard 19 inch relay rack. The MEGA-NODE and its power supply are assembled as an integrated unit. Electronic voltage regulation is incorporated to insure operational stability. Additional refinements include; an automatic time delay to limit the time of operation at high currents, a blower to maintain proper operating temperature for the noise diode, a panel meter which indicates available excess noise temperature in terms of dc current in ma.

The instrument is comprised primarily of three major circuits or sections, namely; the (electronically regulated) power supply, meter and switching circuits, the diode noise generator, and its impedance matching network. These will be discussed separately in Section III, Operation.

I-3 SPECIFICATIONS.

Frequency Range: 1 to 3000 mc.

Output Impedance: 50 ohms into N-Type connector.

Noise Figure Range: 0 to 20 db.

Meter Calibration: Logarithmic in db noise figure, linear in dc ma.

Noise Diode: Bendix Type TT-1.

Power Supply: 200 watts input at 117-volts (±10%), 60-cps.
(Available for 50-cps operation). B+ electronically regulated.

Dimensions: 9¾" x 19½" x 15½".

Weight: 44 lbs.

Accessories Available For Use With The Mega-Node Model 3000.

a. For noise measurements on UHF TV Tuners, use the Kay ULTRAFORMER, a 70-ohm unbalanced to 300-ohm balanced transformer for the frequency range of 450 to 900 mc.

b. With the ULTRAFORMER, use the Kay ULTRAFORMER ADAPTER, a 50 to 70-ohm unbalanced resistance pad.

SECTION II
INSTALLATION

2-1 GENERAL INSTRUCTIONS.

As soon as the MEGA-NODE MODEL 3000 is received it should be visually inspected to determine that the instrument was not damaged during shipment. A careful check of the packing case contents should be made to insure removal of all items shipped. Shortage, or damage should be reported immediately to the carrier and Kay Electric Co., or the Kay representative in your area.

2-2 INSTALLATION.

The MEGA-NODE MODEL 3000 is designed for either bench-top use, or rack mounting (after removal from the cabinet). The operating area selected should be as free as possible from vibration, due to the presence of operating machinery or other sources of vibration. Extreme variations of ambient temperature should also be avoided. Observation of these precautions will result in the user realizing optimum performance of the equipment.

2-3 INTERCONNECTION DATA.

Interconnections between the MEGA-NODE and the associated test equipment will be determined, at least partially, by the requirements of the circuit under test, the type of output measuring device used, etc. Figures 2-1 through 2-3 illustrate the basic interconnections of equipment for determining output power level and noise-figure measurements. It is advised that the sections devoted to operating techniques be reviewed before a measurement method is selected. (See Section 3-2).

Interconnections between equipment should be made with a good quality 50-ohm coaxial cable. Cable lengths should be kept as short as possible consistent with placement of equipment.

Four typical methods that may be used in determining output power level and noise figure are briefly discussed here as an aid to the user in selecting associated equipment.

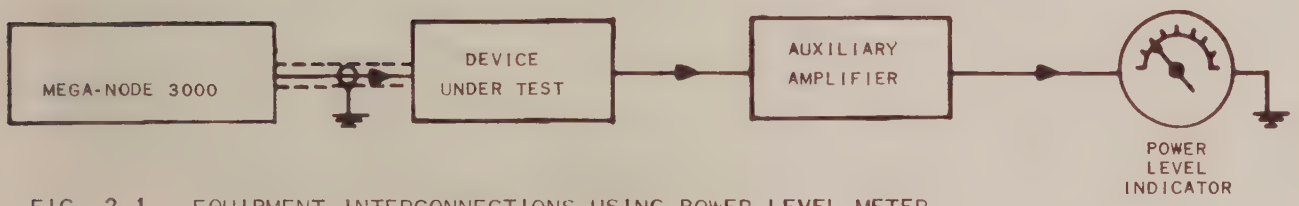


FIG. 2-1 - EQUIPMENT INTERCONNECTIONS USING POWER LEVEL METER

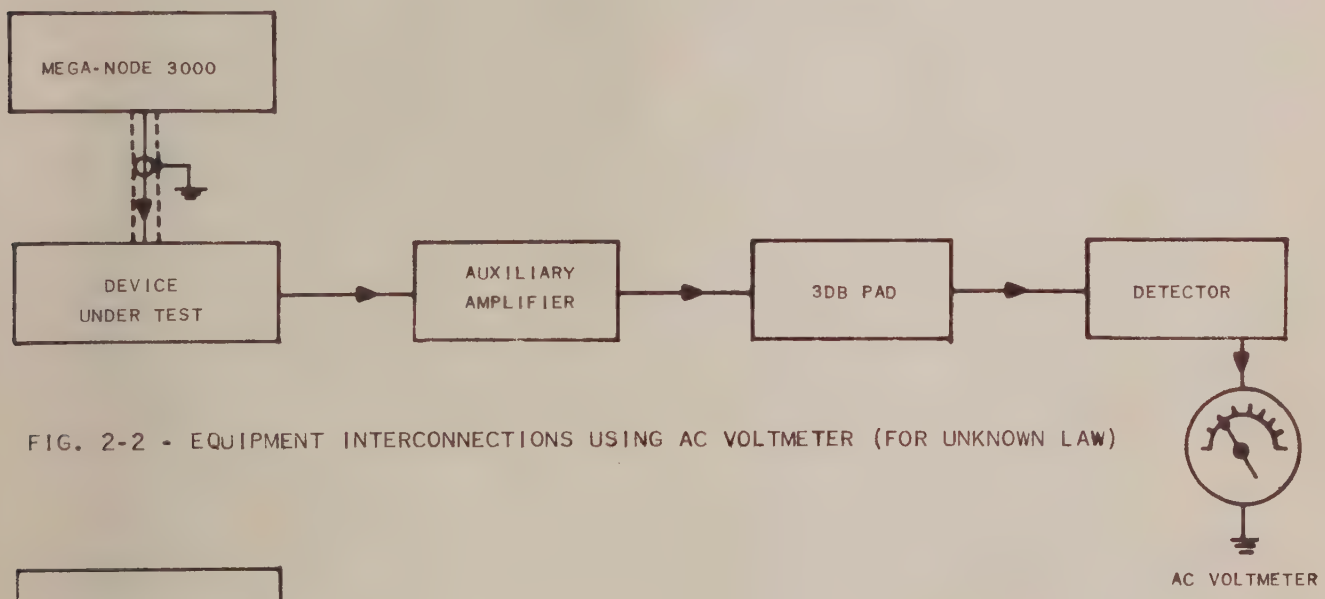


FIG. 2-2 - EQUIPMENT INTERCONNECTIONS USING AC VOLTMETER (FOR UNKNOWN LAW)

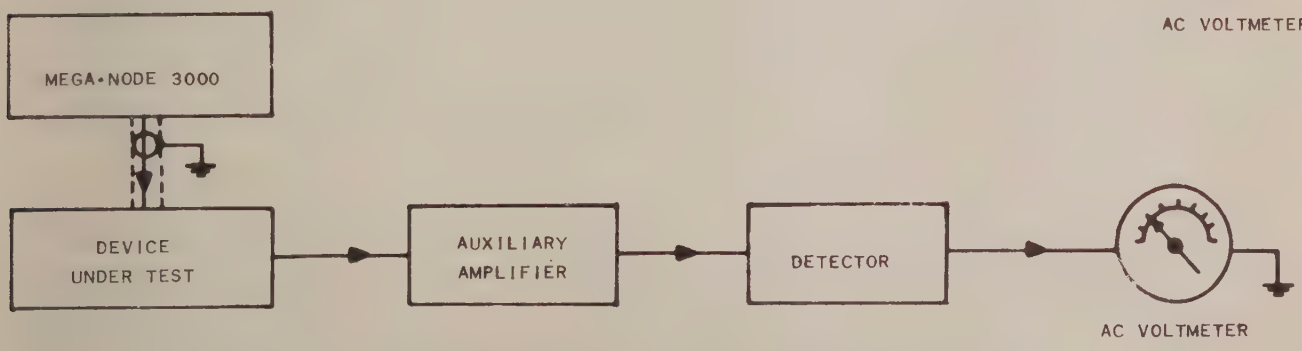


FIG. 2-3 - EQUIPMENT INTERCONNECTIONS FOR RELATIVE NOISE MEASUREMENTS

A. METHOD USING POWER-LEVEL METER.

Figure 2-1 shows the basic interconnection of equipment when using a power-level indicator. If the device under test is a receiver, the power level meter is generally connected at a point following the IF amplifier stages. In an FM receiver, the connection is made before the limiter; in an AM receiver the connection is made ahead of the second detector.

The auxiliary amplifier shown in Fig. 2-1 thru 2-3 can be omitted if the receiver's i-f amplifier output is sufficient to operate the power-level meter. When using an amplifier following the receiver under test, it is important that the amplifier response be at least as wide as the i-f amplifier within the receiver.

B. METHOD USING AN AC VOLTMETER AND FIXED PAD CONNECTIONS.

If a power-level meter is not available, the fixed-pad method may be used for noise-figure measurements. Any available ac voltmeter may be used as the indicating device, since in this method the voltmeter law is not significant. Fig. 2-2. The attenuator pad should be selected so that a proper impedance match exists between the pad and the amplifier. Also, the bandpass characteristics of the pad must be flat over the entire bandwidth of the device under test.

In this method, the output meter is connected following a detector circuit, therefore, any hum (due to insufficient power-supply filtering or stray fields) present in the output of the receiver or amplifier, will be indicated on the ac voltmeter, resulting in inaccurate noise-figure measurements. To avoid this, a bridge-type 60 or 120-cps filter (depending upon the type of power-supply rectifier circuit) should be employed and connected between the detector and the output indicator.

C. METHOD USING AC VOLTMETER CONNECTIONS (Relative Noise Measurement).

The relationship of equipment for this method is shown in Fig. 2-3. This method is not useful in determining noise figure, but does permit relative measurements of noise for comparison of various circuit changes, etc. As in the fixed pad method, a detector is used and the use of a hum filter will depend on the requirements of the particular test set-up.

D. Y-FACTOR METHOD.

This method, using the "excess noise temperature" (Y-factor), offers the best utility since it does not limit the user to a given fixed pad, but allows various amounts of attenuation to be used in determining the noise figure of a given device. With this method, noise figures in excess of 20 db can be measured. The procedure is described in detail in Section 3-3.

SECTION III
OPERATION

3-1 FUNCTION OF PANEL CONTROLS.

The function of the several panel-mounted controls is covered in this section and several methods of measuring noise figure are explained.

1. Power ON-OFF (Switch S-1). This is a toggle-type switch which determines the on-off condition of the instrument.

2. OPERATE (Switch S-2). When this momentary-contact, push-button-type switch is depressed, the MEGA-NODE is placed in operation. Once depressed, the switch may be released and the instrument will continue to operate until an internal thermal cut-out relay (K-2) opens the primary circuit; or the OUTPUT INDICATOR switch (S-3) is rotated to the CUTOFF position. The NOISE output indicator I-2 lights when this switch is depressed.

3. OUTPUT INDICATOR (Switch S-3). This rotary selector switch provides the following functions: In the READ METER position, the meter indicates db noise figure or diode plate current. In the CUTOFF position, all power is removed, thereby permitting a noise reading to be taken without the MEGA-NODE in operation. When the OUTPUT INDICATOR switch is in the ADD 10 DB position, the meter reading is 10 db under the actual noise output. (Full scale current is 100 ma in this position.)

4. COARSE NOISE OUTPUT ADJUSTMENT (Potentiometer R-3). The setting of this control determines the amplitude of the noise output. Rotating the control clockwise increases the output. The panel meter provides an output indication.

5. FINE NOISE OUTPUT ADJUSTMENT (Potentiometer R-2). This control is used as a vernier adjustment in conjunction with the COARSE NOISE OUTPUT ADJUSTMENT potentiometer R-3.

3-2 NOISE FIGURE MEASUREMENT TECHNIQUES.

The following is a detailed description of the various methods used in performing noise figure measurements with the MEGA-NODE. In employing the first two methods (3 db power increase), the device under test and external amplifier must be capable of supplying a power output 3 db above the internal noise level, without exceeding maximum output capabilities of the last stages of the device under test, and the auxiliary amplifier.

1. METHOD USING CALIBRATED POWER LEVEL METER.

The output meter employed in Fig. 2-1 must be a device capable of indicating random noise-power ratios. For best accuracy, it is desirable to use a meter corresponding to rms voltage or current values. It is also best to first determine the linearity of the indicator and auxiliary equipment; this may be accomplished in the following manner:

a. Connect the equipment as shown in Figure 2-1; then, with the MEGA-NODE, introduce a noise into the device under test to provide an output of at least 8 db above the internal noise level of the unit under test. Note the resulting indication on the output meter.

b. Increase the MEGA-NODE output 3 db, as indicated on the panel meter.

c. The resulting deflection change in the output-power indicating device is then a measure of the 3 db change in noise-power output from the equipment under test. Note the new output meter reading.

NOTE: The preceding calibration procedure should be performed with the gain of the system reduced to the point where the operating level of the indicating device is the same as for the ensuing noise-figure measurement.

After determining the calibration of the power-level measuring device, the noise-figure of the device under test may be established. Use the following procedure:

d. With the equipment connected as shown in Fig. 2-1 and the MEGA-NODE turned off, adjust the gain of the auxiliary amplifier to provide an indication on the power-level indicating device equal to the value noted in step a.

e. Place the MEGA-NODE ON-OFF switch (S-1) in the ON position and rotate the OUTPUT INDICATOR switch (S-3) to the READ METER position.

f. Momentarily depress the OPERATE switch (S-2) and rotate the COARSE NOISE OUTPUT ADJUSTMENT potentiometer until the power level indicating device shows a 3-db increase (doubled power). If additional output is required from the MEGA-NODE, rotate the OUTPUT INDICATOR switch to the ADD 10 DB position and again depress the OPERATE switch.

g. Note the db indication on the MEGA-NODE meter scale (add 10 db to this reading if the OUTPUT INDICATOR switch is in the ADD 10 DB position). Correct for transit-time error with the meter scale correction data or by using the chart in Fig. 3-1. The result is the db noise figure of the device under test. (If the device under test is a super-heterodyne receiver, correct for error caused by image response. Refer to paragraph 4 below).

In using the 3-db power increment method, it is obvious that only noise figure measurements up to 20 db may be read directly on the MEGA-NODE meter scale. If, in performing a measurement, maximum output from the MEGA-NODE is reached before a 3-db output power increment is observed, the noise figure of the device under test is above 20 db. The actual noise figure (above 20 db) may be computed from the db increase on the power level meter when the MEGA-NODE'S maximum output is attained. For example: a power-level increment of 1.76 db would indicate a noise figure of 23 db; a power-level increment of 0.969 db would indicate a noise figure of 26 db. Obviously, some loss of accuracy is found when the lower increments are used.

2. METHOD USING FIXED PAD AND AC VOLTMETER.

This method is employed when a power-level indicating device is not available. In this case, any ac voltage indicating device may be used and the accuracy of calibration of the device is insignificant. The equipment should be connected as

shown in Fig. 2-2. (Interconnection data is contained in Section II). The following is the procedure for determining noise figure:

a. With the fixed pad switched out of the circuit (0-db attenuation) and the MEGA-NODE OFF, adjust the gain of the auxiliary amplifier so that the internal noise generated in the device under test provides a deflection on the ac voltmeter. Note this meter indication.

b. Switch in the 3-db pad; place the MEGA-NODE ON-OFF switch in the ON position; rotate the OUTPUT INDICATOR switch to the READ METER position. Momentarily depress the OPERATE switch and adjust the COARSE NOISE OUTPUT ADJUSTMENT potentiometer for an indication on the ac voltmeter equal to the value noted in step a above. (If necessary for increased output, rotate the MEGA-NODE OUTPUT INDICATOR switch to the ADD 10 DB position.)

c. Read the MEGA-NODE panel meter. The db noise figure of the device under test is then: the MEGA-NODE meter reading (plus 10 db, if the OUTPUT INDICATOR switch is on ADD 10 DB) less the transit-time correction determined by the meter chart. If the device under test is a super-heterodyne receiver, refer to paragraph 4 below.

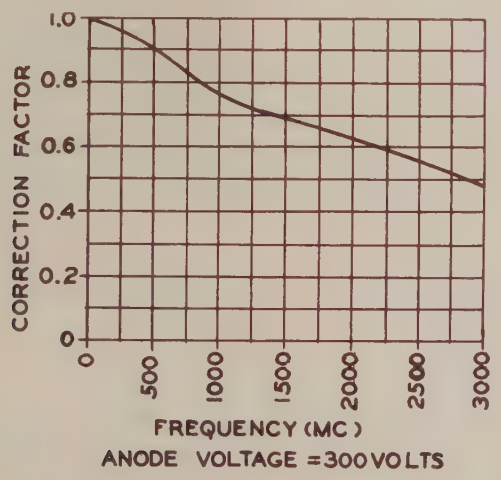


Fig. 3-1, Transit Time Correction Chart

3. RELATIVE NOISE MEASUREMENTS.

Where the actual noise figure measurement is not required and relative indications of noise values will suffice, the following method may be employed:

a. With the equipment connected as shown in Fig. 2-3, adjust the auxiliary amplifier gain so that the internal noise generated in the device under test results in a deflection on the ac meter. Note this reading.

b. Place the MEGA-NODE ON-OFF switch in the ON position; place the OUTPUT INDICATOR switch in the READ METER position; momentarily depress the OPERATE switch. Adjust the noise output, with the COARSE NOISE OUTPUT ADJUSTMENT control, for an increase in the ac voltmeter reading. (If necessary, use the ADD 10 DB position). Note the new ac voltmeter reading. The indication on the MEGA-NODE is then a relative indication.

After circuit changes, etc., are made in the device under test and another noise measurement is made (to show improvement, etc.), a comparative noise reading will be indicated on the MEGA-NODE panel meter, providing the original ac voltmeter readings are maintained.

4. CORRECTION FOR SUPERHETERODYNE RECEIVER.

In measuring the Noise Figure of a superheterodyne receiver, a correction must be applied to the current reading obtained. Since the MEGA-NODE produces noise at both the signal and the image frequencies, the correction factor must be such as to give the dc-generator current that doubles the noise output power if there had been no image response. If A and B are the average power gains at signal and image frequencies respectively, the multiplying factor is: $\frac{A}{A+B}$

3-3 ACCURACY OF NOISE FIGURE MEASUREMENTS USING THE MEGA-NODE 3000.

Since all noise-figure measurements, using a nominal 50-ohm noise source, are related to a generator having an accurately known available noise power and a vswr of 1, it follows that when the noise generator internal resistance varies from a value of 50 ohms, the measured results will have errors. The errors in a temperature-limited diode noise source can be broken down into three types, namely:

1. Meter error, which can be neglected in most cases.

2. Variance of available noise power, due to variance of generator resistance from a value of exactly 50 ohms. This error can be neglected in the MEGA-NODE 3000 below 250 mc.

3. Error due to source mismatch. When the reference source impedance for noise figure is established as a 50-ohm generator, having a vswr of 1, any variance from this condition will produce an error.

The source mismatch error cannot readily be computed, since it varies with various types of devices that may be tested. It can, however, be eliminated by means of a reactive tuning stub inserted between the output of the MEGA-NODE and the device under test, and adjusted so that the impedance that the device under test sees, looking back into the MEGA-NODE, is a 50-ohms resistance.

3-4 METHOD USING THE "EXCESS NOISE TEMPERATURE (Y-FACTOR)".

This method offers the best utility since it does not confine the user to a given fixed pad but allows various amounts of attenuation to be used in determining the noise figure of a given device. This method also allows noise figures in excess of 20 db to be measured.

The noise figure using the Y-factor method is symbolized as follows:

$$\text{Noise Figure (db)} = 10 \log_{10} \frac{\left(\frac{Th}{To} - 1\right) - Y\left(\frac{Ta}{To} - 1\right)}{Y-1}$$

where

$\frac{Th}{To} - 1$ = excess noise temperature

Th = equivalent noise temperature output of the MEGA-NODE when the noise diode is turned on.

To = standard reference temperature of 290°K

Ta = ambient temperature

$Y = \frac{\text{noise output (diode on)}}{\text{noise output (diode off)}}$

where:

Noise output = output of system being tested.

Since most measurements are usually made in environments approaching 290°K (18°C) the above equation can be simplified to:

$$\text{Noise Figure (db)} = 10 \log_{10} \frac{\frac{Th}{To} - 1}{Y - 1}$$

The MEGA-NODE indicates the available excess noise temperature directly on the panel meter in terms of dc current in ma.

D.C. Current ma	Excess Noise Temperature $\frac{Th}{To} - 1$
1	1
5	5
10	10
20	20
50	50
100	100
etc.	

The Y-factor can be measured by either method shown in Fig. 2-2 and Fig. 2-3. In Fig. 2-2, Y becomes the ratio of the output noise power when the noise diode is turned on, to the output noise power when the diode is off. In Fig. 3, the Y-factor

(in db) is equal to the amount of attenuation (any amount) for a fixed value of noise-diode current (ma) that produces the same reading of the power-level meter when the noise diode is alternately on and off.

Example using set-up in Fig. 2-2.

a. With the noise diode off, the power-level indicator reads 10 milliwatts.

b. With the noise diode turned on and adjusted to 10 ma, the power level meter reads 20 milliwatts.

$$\text{Noise Figure (db)} = 10 \log_{10} \frac{10}{2-1}$$

$$= 10 \log_{10} 10$$

$$= 10 \text{ DB}$$

Example using set-up in Fig. 2-3.

a. With the noise diode off, the attenuator is set to 5 db for a given value of ac-voltmeter reading.

b. With noise diode on and set to 10 ma, the attenuator was set to 8 db to produce the same voltmeter reading as in step a.

$$\text{Y-factor (db)} = 8 \text{ db} - 5 \text{ db}$$

$$= 3 \text{ db}$$

Changing to a power ratio

$$Y = 2$$

and

$$Y - 1 = 1$$

$$\text{Noise Figure (db)} = 10 \log_{10} \frac{\frac{Th}{To} - 1}{Y - 1}$$

$$= 10 \log_{10} \frac{10}{1}$$

$$= 10 \text{ DB}$$

When transit time corrections are necessary they should be applied to the excess noise temperature used in the standard noise-figure formula.

Example:

Frequency = 1500 megacycles

Noise Diode current = 10 ma

then

correction = 0.7 (see correction chart)

and

actual excess noise temperature $\frac{Th}{To} - 1 = 7$

SECTION IV
THEORY OF OPERATION

4-1 NOISE MEASUREMENT THEORY.

The "noise diode" method of measuring receiver Noise Figures is quite fundamental and permits simplification in procedure and greater accuracy than other methods. Techniques employing a continuous-wave signal generator are subject to a noticeable error in the measurement of the extremely small power levels employed, especially at the higher frequencies, and a separate measurement of receiver bandwidth is required. The use of a temperature-limited diode as a noise generator permits cancellation of the bandwidths involved, since the diode noise is distributed the same as the receiver noise with respect to frequency. This method, therefore, requires no measurements nor knowledge of bandwidth or gain. The mean-squared noise current supplied by the diode is proportional to the dc plate current which can be easily and accurately measured.

4-2 NOISE FIGURE MEASUREMENTS.

Any receiver, other than a hypothetical ideal receiver, will have noise generated within the receiver itself in addition to the noise supplied by the signal source. The Noise Figure is a figure of merit by which the noise of a given receiver system is compared with that of an ideal receiver in a similar system, but having the same bandwidth. The noise supplied to the ideal receiver by the signal source will be

$$e_t^2 = 4KTR_a\Delta f \qquad (1)$$

Where:

e_t^2 = Open-circuited mean-squared thermal noise voltage.

K = Boltzmann's constant, 1.37×10^{-23} joules/°K.

T = Temperature of resistance in °K.

R_a = Internal resistance of the source in Ω.

Δf = Receiver noise bandwidth in cps.

The noise present in the given receiver will be that supplied by the signal source plus the noise generated within the receiver itself. The noise generated within the receiver may be referred to the signal source as a mean-squared noise voltage. Call this voltage e_n^2.

Then by definition:

$$\text{Noise Figure} = F = \frac{e_n^2}{e_t^2} \qquad (2)$$

To determine e_n^2 the "noise diode" is connected to the receiver through the signal source impedance R_a. With the noise source turned off, the noise-power output of the receiver is measured. Then the noise source is turned on and the diode direct plate current is increased from its lowest value to that value which just doubles the receiver noise-power output. The mean-squared noise current of the diode is given by

$$i^2 = 2eI_b\Delta f \qquad (3)$$

Where:

i = Root-mean-squared noise current in amps.

e = Charge on electron (1.59×10^{-19} coulombs).

I_b = DC diode plate current in amperes.

Δf = The noise bandwidth of the receiver in cps.

The mean-squared voltage developed by this noise current across the internal impedance of the source (R_a) will be

$$e_n^2 = (iR_a)^2 = 2eI_b \Delta fRa^2 \qquad (4)$$

Substituting equations (1) and (4) in equation (2).

$$F = \frac{eI_bR_a}{2KT} \qquad (5)$$

It is usually permissible to assume T to be room temperature; i.e., 290°Kelvin, 17°C., 63°F., in which case equation (5) reduces to:

$$F = 20I_bR_a \qquad (6)$$

Variation of this reference temperature between 270°K and 300°K ordinarily will affect the Noise Figure by less than about ±5%, which is equivalent to ±0.2 db. The value of F given by (6) is a power ratio. It may be expressed in db by the relationship:

$$F_{db} = 10 \log_{10}F \qquad (7)$$

4-3 REQUIREMENTS OF THE "NOISE-DIODE" GENERATOR.

a. Resistor R_a, which is taken as the internal impedance of the signal source, must be constant over the noise bandwidth of the unit under test.

b. The "Noise Diode" must be fully temperature limited. This is a condition of equation (3) and it is well to observe that the ac plate resistance of the diode, which shunts R_a, is sufficiently high to be negligible only when the diode is completely temperature limited. This condition is met in the MEGA-NODE for all values of diode dc plate current less than 100 ma.

4-4 ANALYSIS OF POWER SUPPLY CIRCUIT.

A full wave rectifier, incorporating six silicon rectifiers (D-1 thru D-6), furnishes a dc voltage at the input of the filter choke L-2. After filtering, the dc potential (B^+) is electronically regulated to compensate for power-line voltage excursions and changes in power-supply load.

From the schematic diagram, it will be noted that the supply works through 50 ohms (R-10, R-11) to chassis-ground. The three type 6AQ5 tubes are effectively connected in parallel across the output and act as a variable resistive load.

Regulator action can best be explained by considering a power-line fluctuation constituting a voltage rise. This rise of input voltage will be reflected through T-3, the rectifier and filter sections, and at the grids of V-6; since there is a direct connection between the filter choke L-2 and the grids of V-6.

The potential rise at the grids of V-6 reduces the cathode-to-grid bias, permitting an increase of current through the tube and a voltage rise across the cathode resistor R-36. Similarly, since there is a direct connection between the cathode of V-6 and the grids of V-2, V-3 and V-4, they are pulled more positive, lowering the impedance of these tubes; thus, permitting increased current flow through them and the gas-discharge tube V-5.

This increase of current flow through V-5 and the voltage divider, composed of R-39 and R-40, is reflected at the grid of V-7, permitting an increase of current through this tube causing a potential drop at the plate; since the cathode voltage cannot rise because of the clamping action at 105 volts by V-8.

The drop in plate potential at V-7 is seen at the grids of V-6, increasing the grid bias here, thus causing a drop of cathode potential across R-36. This action pulls the grids of V-2, V-3 and V-4 less positive, increasing the impedance of these tubes; thus reducing the current through them. Since the B^+ is taken from the cathode resistors of V-2, V-3 and V-4, this potential is held steady by the regulating action just described.

Conversely, a power-line fluctuation constituting a voltage drop, is compensated by regulator action in reverse of that for a power-line voltage rise. Power-line fluctuations of short duration (transients) are passed by capacitor C-12 to the grid of V-7, since this capacitor presents a low impedance to sharp transients. Capacitor C-12 also sees residual ripple as voltage changes and feeds this information to the grid of V-7 for compensating action in the regulator circuit. Capacitors C-15A and B are of sufficient capacity to maintain a steady charge, further stabilizing the output.

SECTION V
MAINTENANCE

5-1 INTRODUCTION.

This section covers recommended procedures to locate circuit malfunctions, instructions for adjustment of internal controls, and other service topics.

If the MEGA-NODE 3000 appears to be defective in any respect, first ascertain that the cause is not in the associated equipment, or in the interconnections between equipment. Since trouble-shooting consists mainly of a process of elimination, the operator will naturally seek to isolate the section of the system that is not performing properly, and then the specific circuit and finally, the defective component(s). A systematic check-out of equipment should be made.

a. Determine that the power switch is set to ON position and that proper ac power is applied to the instrument.

b. Check all fuses for open circuit, or loose contact in the fuse holder. (There are three fuses in the MEGA-NODE, F-1, F-2 and F-3. See schematic for values and locations.)

c. Determine that all tubes are fully seated in their respective sockets and all filaments lit.

d. Check all inter-connecting cables and fittings for open or short circuit.

Further trouble-shooting checks will be made in accordance with the operator's observations of equipment symptoms. A systematic checkout of circuit performance should serve to isolate the cause.

TROUBLE LOCATION CHART	
SYMPTOM	PROBABLE CAUSE AND CORRECTION
Equipment fails to operate when OPERATE switch is depressed. Blower does not function.	S-1 open; F-1 blown. If new fuse also blows, check T-1, T-2 and blower.
Equipment does not remain in operation after OPERATE switch is released.	Check contacts on K-1, K-2 and S-3A.
Zero meter indication. Noise indicator lamp indicates normally, no output from instrument.	Check TT-1 diode; check diode plate voltage; if zero, check F-2 and plate supply components.
Zero meter indication; noise indicator lamp indicates normally. Normal noise output from instrument in ADD 10-DB position. No output in READ METER position.	Check meter and R-9 for open circuit.
Lower than normal meter indication in either switch position.	Check bridge rectifier components. Check plate supply voltage and secondary voltage of T-1. Check C-1 and C-2. Check TT-1 for low emission.

5-2 ADJUSTMENT OF INTERNAL CONTROLS.

The following internal adjustments, although factory-set, may require attention after diode aging, component replacement, etc. The following procedure should be used in setting these controls.

1. PRESET HIGH R-1. This control should be set to provide a slightly more than full-scale reading on the panel meter when the COARSE and FINE NOISE OUTPUT ADJUSTMENTS are fully clockwise and the OUTPUT INDICATOR switch is in the ADD 10-DB POSITION.

2. PRESET LOW R-4. This control should be adjusted with the OUTPUT INDICATOR switch S-3 in the READ METER position. Adjust R-4 for a slightly more than full-scale panel meter deflection when the COARSE and FINE NOISE OUTPUT ADJUSTMENTS are fully clockwise.

3. TIME DELAY ADJUSTMENT K-2. Thermal relay K-2 can be adjusted to vary the delay time by means of a screw located on top of the device.

4. METER MULTIPLIER ADJUSTMENT R-7. This control is initially factory-set (and cemented in place) for the correct meter calibration. Should it become necessary to replace a component in the meter circuit, loosen the cement and reset R-7 for the correct meter calibration in the ADD 10-DB position. An external, dc 0-100 ma. meter, should be connected in series with the plate supply to the noise diode; the panel meter may be calibrated using the external meter as a standard.

5. B+ ADJUSTMENT R-39. This control permits adjustment of the B+ voltage to 300 volts, as required for proper operation of the MEGA-NODE.

5-3 REPLACEMENT OF NOISE DIODE (TT-1).

1. Unsolder the bifilar choke coil from the TT-1 diode. Remove the two screws in the side chassis-bracket that supports the insulated choke coil. Use a low temperature iron and be careful not to change the spacing of the first three turns on the choke coil (nearest the TT-1 diode).

2. Remove the TT-1 assembly by removing the two screws in the front panel near the output jack and four screws in the chassis side-bracket.

3. Remove the cooling fins and the two side-brackets of the assembly by removing their related supporting screws and nuts. The remaining parts consist of the TT-1 diode and the two flange assemblies which are easily slipped off with a rotating action. While installing the new tube, care should be taken to properly seat the flanges so that the front and back diode connections properly engage their corresponding sleeves. Reverse the process during reassembly from the foregoing process of disassembly. Cut the tube's inner filament connection to the same length as on the original tube before resoldering the choke coil.

4. Before applying power make sure that the tube is properly wired and that no shorts exist (check this with a suitable ohmmeter).

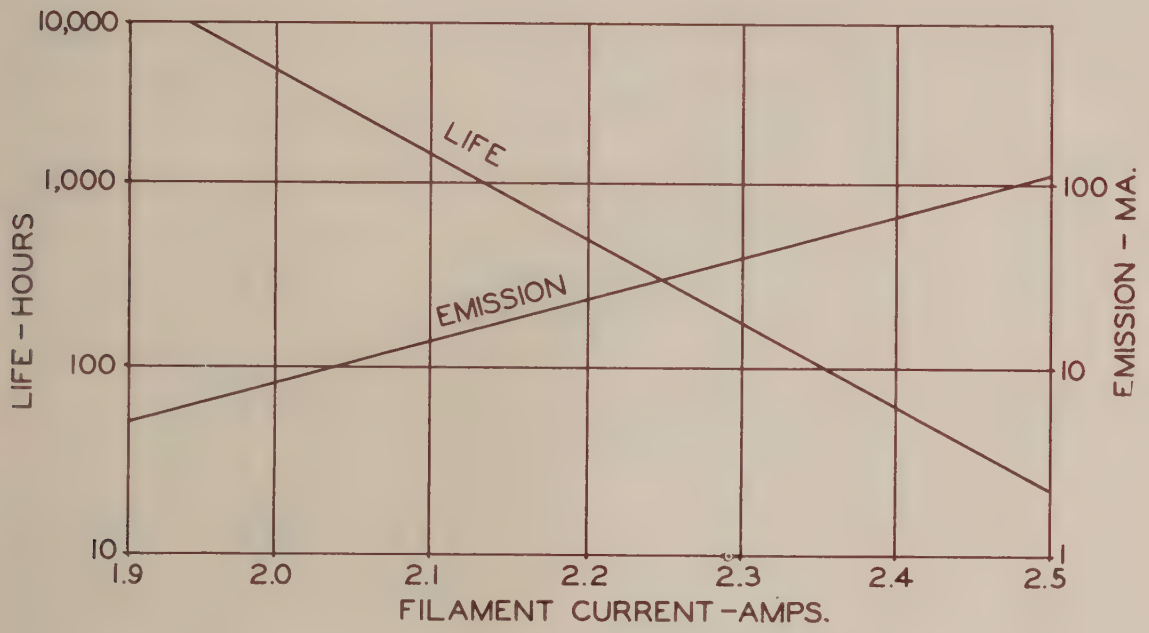
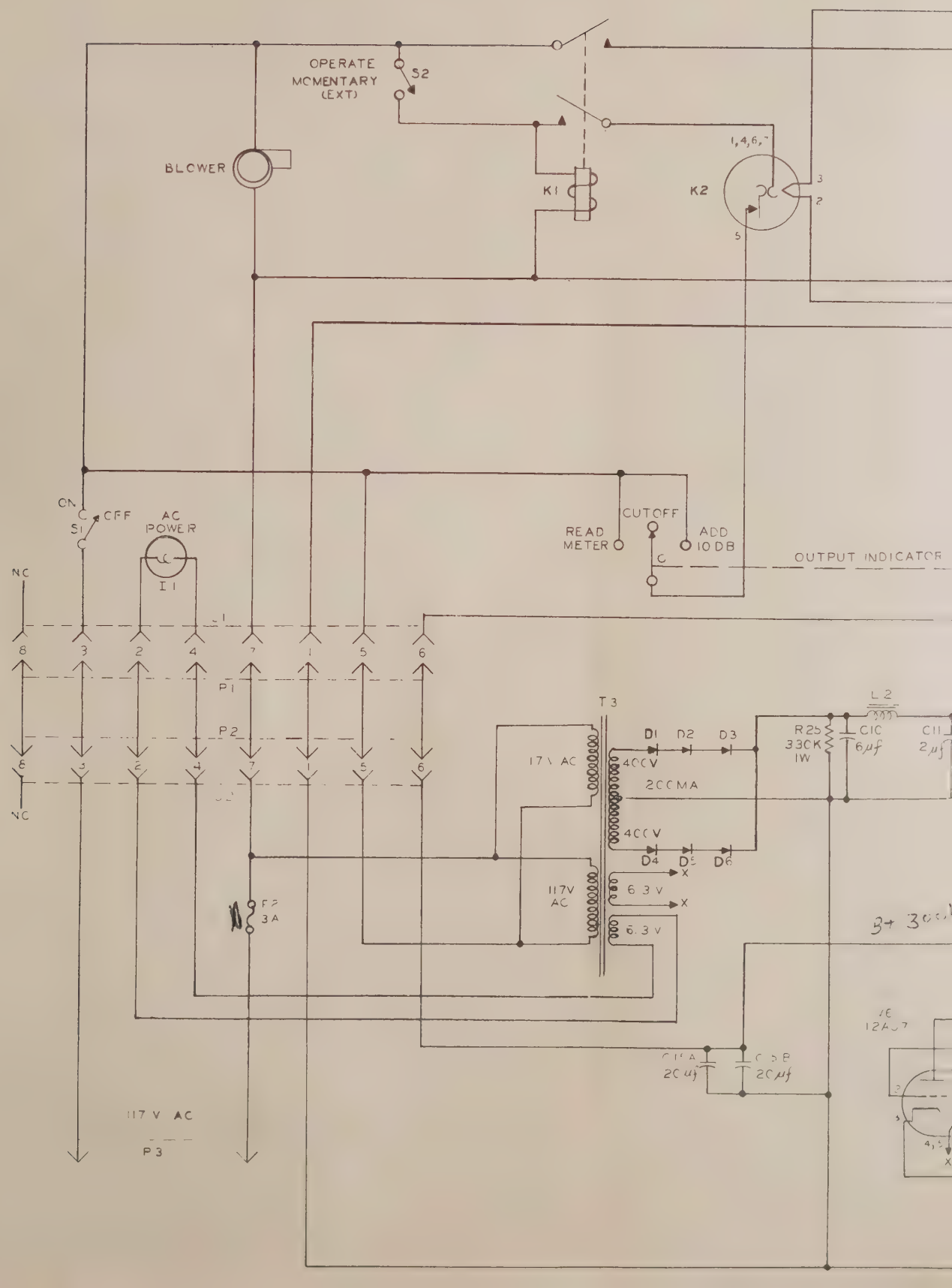
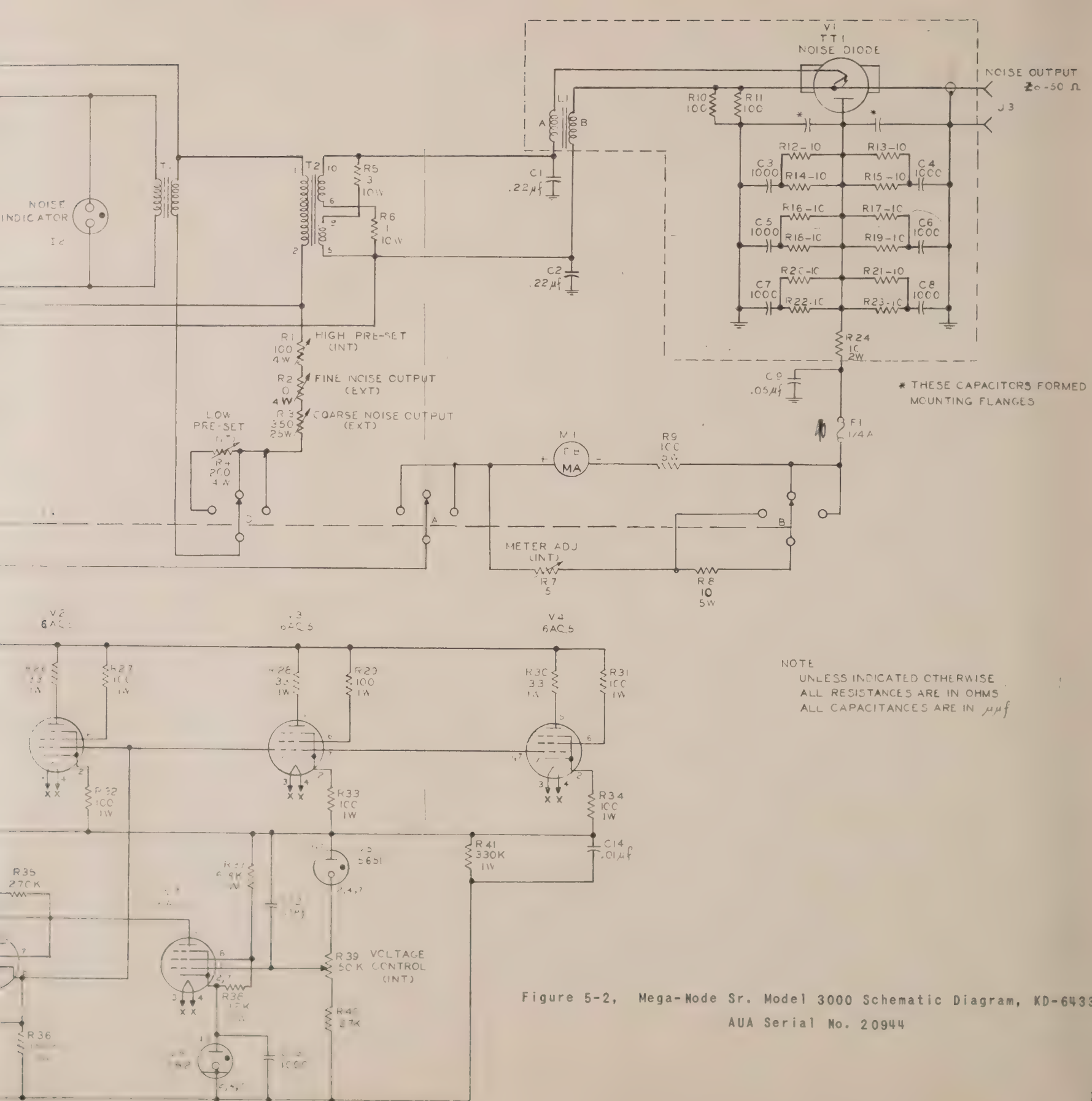


Figure 5-1, Noise Diode Life Expectancy Chart.

5-4 PARTS LIST

Dwg. Symbol No.	Description	Kay Part No.
	CAPACITORS:	
C-1	0.22μF, 50V, MYLAR	6411-1
C-2	0.22μF, 50V, MYLAR	6411-1
C-3	1000μμF, 500V, CERAMIC (BUTTON)	6707-1
C-4	1000μμF, 500V, CERAMIC (BUTTON)	6707-1
C-5	1000μμF, 500V, CERAMIC (BUTTON)	6707-1
C-6	1000μμF, 500V, CERAMIC (BUTTON)	6707-1
C-7	1000μμF, 500V, CERAMIC (BUTTON)	6707-1
C-8	1000μμF, 500V, CERAMIC (BUTTON)	6707-1
C-9	0.05μF, 600V, PAPER	6353-3
C-10	6μF, 600V, OIL-FILLED	1532
C-11	2μF, 600V, OIL-FILLED	333
C-12	0.1μF, 400V, PAPER	6353-4
C-13	1000μμF, 500V, CERAMIC (TUBULAR)	6361-25
C-14	0.01μF, 500V, CERAMIC DISC	6360-6
C-15 A & B	20/20μF, 450V, DUAL ELECTROLYTIC	6355-10
D-1 THRU D-6	SILICON RECTIFIER F6	6357-3
F-1	FUSE, ¼ AMP. 250V	470
F-2	FUSE, 3 AMP. 250V	245
I-1	LIGHT INDICATOR #44	249
I-2	LIGHT INDICATOR NE51	1753
J-1	JACK S-308-SB	401
J-2	JACK S-308-SB	401
J-3	JACK, SPECIAL (MODIFIED)	5943
K-1	RELAY BO-6A-110-115	915
K-2	THERMAL RELAY	2489
L-1	COIL, SPECIAL	L1/6433C
L-2	CHOKE, 8.5 HENRY	5501
M-1	METER 0-10 MA DC	1947
P-1	PLUG P-308-CCT	453
P-2	PLUG P-308-CCT	453
P-3	AC LINE CORD	328
	RESISTORS: (UNLESS OTHERWISE INDICATED, ALL COMPONENTS ARE FIXED COMPOSITION, 1 WATT, 10% TOLERANCE RESISTORS.)	
R-1	100, 4 WATT, POT, WIREWOUND	4334
R-2	10, 4 WATT, POT, WIREWOUND	6605
R-3	350, 25 WATT, POT, WIREWOUND	4267
R-4	200, 4 WATT, POT, WIREWOUND	4335
R-5	3, 10 WATT, WIREWOUND	6774
R-6	1, 10 WATT, WIREWOUND	5987-1
R-7	5, 2 WATT, POT, WIREWOUND	2486
R-8	10, 5 WATT, WIREWOUND	5988
R-9	100, 5 WATT, WIREWOUND	5989
R-10	100, ½ WATT, 1% TOLERANCE	6775
R-11	100, ½ WATT, 1% TOLERANCE	6775
R-12 THRU R-23	10, ½ WATT	1001-E
R-24	10, 2 WATT	1001-H
R-25	330K	3341-G
R-26	33	3301-G
R-27	100	1011-G
R-28	33	3301-G
R-29	100	1011-G
R-30	33	3301-G
R-31	100	1011-G
R-32	100	1011-G
R-33	100	1011-G


OPERATE
MOMENTARY
(EXT)
S2
BLOWER
K1
K2
1,4,6,7
3
2
5
ON
OFF
S1
AC
POWER
I1
READ
METER
CUTOFF
ADD
10 DB
C
OUTPUT INDICATOR
NC
8
3
2
4
7
1
5
6
P1
P2
P3
T3
117 V AC
D1
D2
D3
400V
200MA
400V
D4
D5
D6
X
6.3 V
R25
33CK
1W
C1C
6μf
C11
2μf
L2
F2
3A
C1?A
20μf
C?B
20μf
117 V AC



NOTE
UNLESS INDICATED OTHERWISE
ALL RESISTANCES ARE IN OHMS
ALL CAPACITANCES ARE IN μμf

Figure 5-2, Mega-Node Sr. Model 3000 Schematic Diagram, KD-6433-C
AUA Serial No. 20944

Dwg. Symbol No.	Description	Kay Part No.
R-34	100	1011-G
R-35	270K, ½ WATT	2741-E
R-36	150K	1541-G
R-37	6.8K	6821-G
R-38	12K, 2 WATT	1231-H
R-39	50K, 2 WATT, POT, VARIABLE	118
R-40	27K, ½ WATT	2731-E
R-41	330K	3341-G
S-1	SWITCH, TOGGLE, SPST	255-C
S-2	SWITCH, PUSHBUTTON SPST	2845
S-3 A,B,C,D	SWITCH, 2 WAFER, 3 POSITION	2559RM
T-1	TRANSFORMER, VR6111	4288-60~
T-2	TRANSFORMER, P2393	4289
T-3	TRANSFORMER, POWER	2520
V-1	TUBE, TT1 (DIODE)	1708
V-2	TUBE, 6AQ5	6AQ5
V-3	TUBE, 6AQ5	6AQ5
V-4	TUBE, 6AQ5	6AQ5
V-5	TUBE, 5651	5651
V-6	TUBE, 12AU7	12AU7
V-7	TUBE, 6AG5	6AG5
V-8	TUBE, OB2	OB2
	BLOWER MOTOR ASSEMBLY	2488

5-5 RESHIPMENT INSTRUCTIONS.

Permission to return equipment should in every case be obtained from the factory or an accredited Kay representative before return shipment is made.

If the MEGA-NODE 3000 is returned to the factory for repairs, it should be wrapped in protective paper and then adequately padded with soft wadding to cushion the instrument during transit. The wrapped and padded unit should then be packed in a wooden box or suitable carton.

A packing slip should be included in the carton furnishing identification of the shipper. The packing slip should also reference the instrument type and serial number. A statement pertaining to the extent of malfunction should be included to acquaint service personnel with the purpose of returning the instrument. Return shipment must be made with shipping charges prepaid.

MEGA-NODE 3000 ADDENDUM

April, 1961

MEGA-NODE MODEL 3000 instruments above serial number 22140 are assembled in accordance with Schematic No. KD-6433-D. Incorporated changes necessitated relocation and change of function of some of the panel controls. Those changes which affected operation and adjustment of the instrument are discussed in this addendum.

A. Major changes to the front panel and the controls mounted on it are:

1. The meter selector switch (S-4) now has 4 positions, viz., SUBTRACT 5 DB, READ DIRECT, ADD 5 DB and ADD 10 DB.

2. The CUTOFF switch, which was part of the OUTPUT INDICATOR switch (S-3 on KD-6433-C), is now a separate momentary push-button switch, S-3 on KD-6433-D.

B. Major changes affecting components and circuitry are:

1. The variable meter shunt (R-7 on KD-6433-C) is replaced by fixed 1.0% resistors (R-9, R-42 thru R-45 on KD-6433-D). These fixed shunts are switched across the meter by S-4B.

2. Two new internal controls (R-2, R-3, Schematic KD-6433-D) have been added. The addition of these controls makes it necessary to change the instructions contained in Section 5-2, page 16, to read as follows. This sequence should be followed at all times.

   a. Check the B+ voltage, which should be 300 volts as measured between pins 1 and 6 of J-1, J-2. Re-adjust the VOLTAGE CONTROL R-39, if necessary, to obtain this voltage.

   b. Set the COARSE INCREASE control (R-6) fully clockwise and the FINE INCREASE control (R-5) fully counterclockwise.

   c. Set the output indicator switch (S-4) to the +10 DB position.

   d. Push the MOMENTARY OPERATE switch (S-2).

   e. Now adjust the internal PRE-SET #4 control for a full scale meter reading, indicating noise diode d-c current.

   f. Set the output indicator switch to the +5 DB position and adjust PRE-SET #3 control for full scale meter reading.

   g. Set S-4 to the READ DIRECT position and adjust RRE-SET #2 for full scale meter reading.

   h. Finally, set S-4 to the -5 DB position and adjust PRE-SET #1 for full scale meter reading.

   i. The time delay of relay K-2 can be adjusted by means of a screw located on top of the device. To do this, set the meter selector switch to the ADD 10 DB position and set the COARSE control for full-scale meter reading. Proper adjustment will result in cut-off occurring between 30 and 90 seconds.

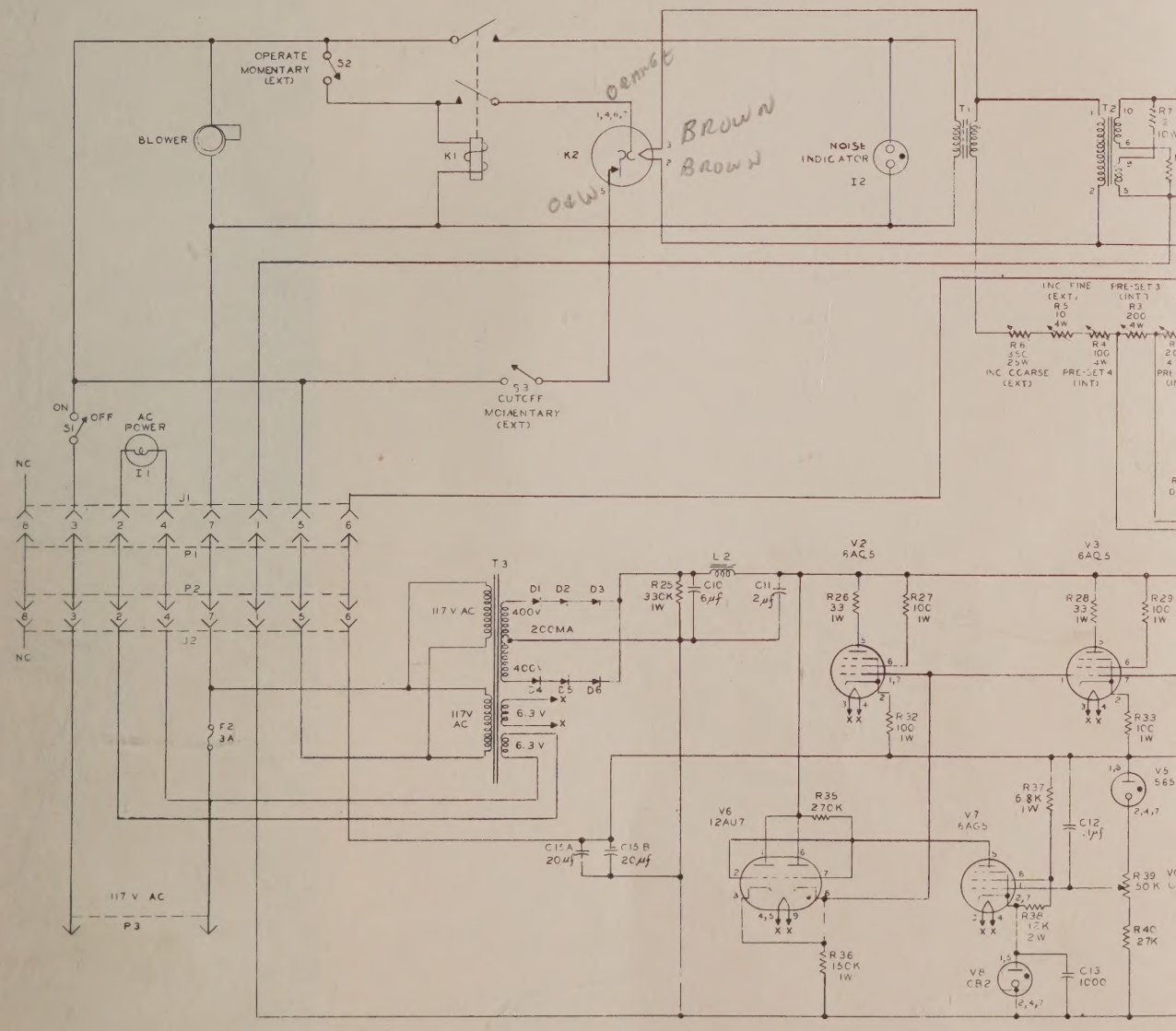
POSITION OF OUTPUT INDICATOR SWITCH S-4	DIODE TUBE CURRENT
SUBTRACT 5 DB	3.16
READ DIRECT	10
ADD 5 DB	31.6
ADD 10 DB	100

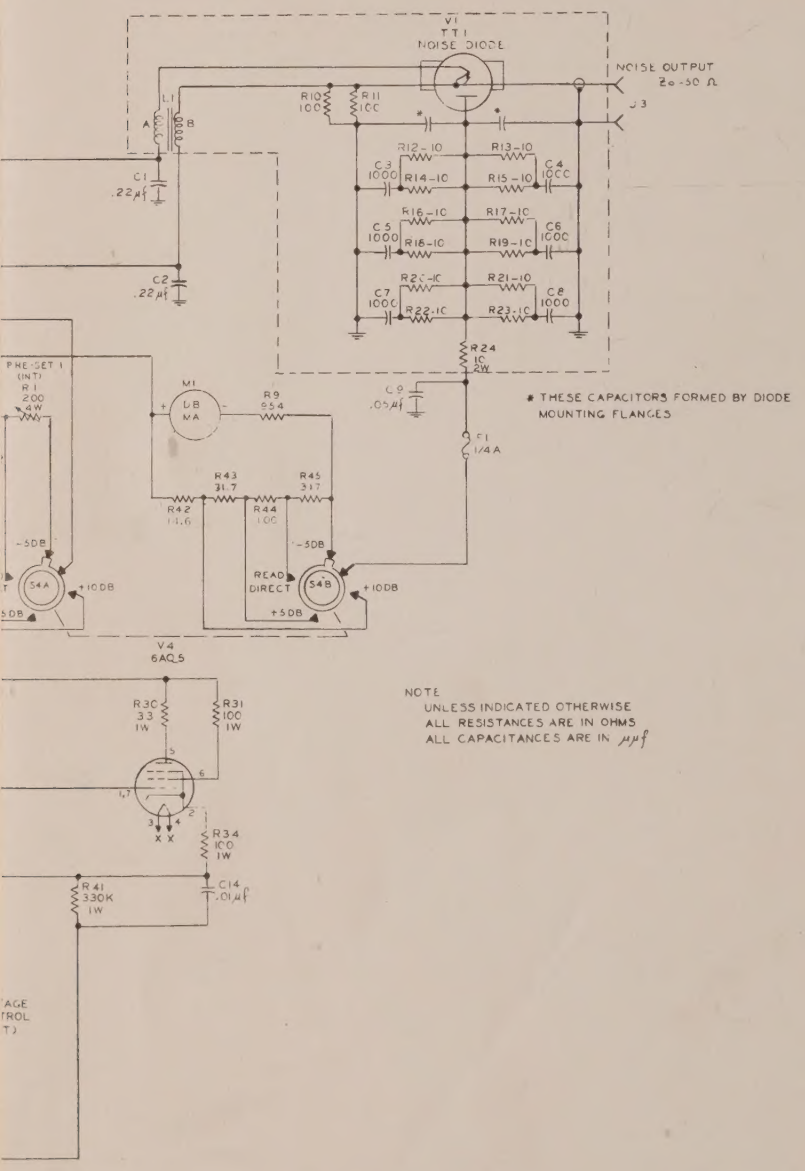
Fig. 5-3 Diode Current in Milliamperes for the 4 positions of S-4.

PARTS LIST FOR SCHEMATIC NO. KD-6433-D

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
	Capacitors:	
C-1	0.22μf, 50V, mylar	6411-1
C-2	0.22μf, 50V, Mylar	6411-1
C-3 thru C-8	1000μμf, 500V, ceramic (button)	6707-1
C-9	0.05μf, 600V, paper	6353-3
C-10	6μf, 600V, oil-filled	1532
C-11	2μf, 600V, oil-filled	333
C-12	0.1μf, 400V, paper	6353-4
C-13	1000μμf, 500V, ceramic (tubular)	6361-25
C-14	0.01μf, 500V, ceramic disc	6360-6
C-15 A & B	20/20μf, 450V, dual electrolytic	6355-10
D-1 thru D-6	Silicon Rectifier F6	6357-3
F-1	Fuse, ¼ amp, 250V	470
F-2	Fuse, 3 amp, 250V	245
I-1	Light indicator #44	249
I-2	Light indicator NF51	1753
J-1 & J-2	Jack S-308-AB	401
J-3	Jack UG-1187/U (modified)	5943
K-1	Relay BO-6A-110-115	915
K-2	Thermal Relay	2489
L-1	Coil, special	L1/6433C
L-2	Choke, 8.5 henry	5501
M-1	Meter, 0-1 MA DC	1947BX
P-1	Plug P-308-CCT	453
P-2	Plug P-308-CCT	453
P-3	AC Line Cord	328
	Resistors: ((Unless otherwise indicated, all components are fixed composition, 1 watt, 10% tolerance resistors.)	
R-1 thru R-3	200, 4 watt, pot wirewound	4335
R-4	100, 4 watt, pot wirewound	4334
R-5	10, 4 watt, pot wirewound	6605
R-6	350, 25 watt, pot wirewound	4267
R-7 & R-8	2, 10 watt, wirewound	2P01-K
R-9	954, ¼ watt, 1% tolerance wirewound	6558-65
R-10 & R-11	100, ¼ watt, 1% tolerance	6558-26
R-12 thru R-23	10, ½ watt	1001-F
R-24	10, 2 watt	1001-H
R-25	330 K	3341-G
R-26	33	3301-G
R-27	100	1011-G

DWG. SYMBOL NO.	DESCRIPTION	KAY PART NO.
R-28	33	3301-G
R-29	100	1011-G
R-30	33	3301-G
R-31 thru R-34	100	1011-G
R-35	270 K, ½ watt	2741-E
R-36	150 K	1541-G
R-37	6.8 K	6821-G
R-38	12 K, 2 watt	1231-H
R-39	50 K, 2 watt, pot, variable	118
R-40	27 K, ½ watt	2731-E
R-41	330 K	3341-G
R-42	14.6, ¼ watt, 1% tolerance wirewound	6558-61
R-43	31.7, ¼ watt, 1% tolerance wirewound	6558-62
R-44	100, ¼ watt, 1% tolerance wirewound	6558-63
R-45	317, ¼ watt, 1% tolerance wirewound	6558-64
S-1	Switch, toggle, S.P.S.T.	255-C
S-2	Switch, push button S.P.S.T.	2845
S-3	Switch, push button S.P.S.T.	6928
S-4 A & B	Switch, 2 wafer, 4 position	6927
T-1	Transformer, regulating	4288-60 ~
T-2	Transformer, P2393	4289
T-3	Transformer, power	2520
V-1	Tube, TT1 (noise diode)	1708
V-2 thru V-4	Tube, 6AQ5	6AQ5
V-5	Tube, 5651	5651
V-6	Tube, 12AU7	12AU7
V-7	Tube, 6AG5	6AG5
V-8	Tube, OB2	OB2
	Blower Motor Assy.	2488
For 50 cps units:		
T-1	Transformer, regulating	4288-50 ~


OPERATE MOMENTARY (EXT)
S2
BLOWER
K1
K2
ORANGE
BROWN
BROWN
GREEN
NOISE INDICATOR
I2
T1
T2
INC FINE (EXT) R5 10 4W
PRE-SET 3 (INT) R3 200 4W
R6 550 25W INC COARSE (EXT)
R4 100 4W PRE-SET 4 (INT)
S3 CUTOFF MOMENTARY (EXT)
ON
S1
OFF
AC POWER
I1
NC
J1
P1
P2
J2
NC
T3
117 V AC
400v
200MA
400v
6.3 V
6.3 V
D1
D2
D3
D4
D5
D6
F2 3A
117V AC
117 V AC
P3
R25 33CK 1W
C10 6μf
C11 2μf
L2
V2 6AQ5
R26 33 1W
R27 100 1W
R32 100 1W
V3 6AQ5
R28 33 1W
R29 100 1W
R33 100 1W
V5 5651
R37 6.8K 1W
C12 .1μf
R39 50K
R38 15K 2W
R40 27K
V8 CB2
C13 1000
V6 12AU7
R35 270K
R36 150K 1W
V7 6AG5
C15A 20μf
C15B 20μf



Mega-Node Model 3000 Schematic, KD-6433-D
AUA Serial No. 22140